WHAT IS CLAIMED IS:

1. A method of calculating a radar cross section of an aircraft component having an axi-periodic structure comprising the steps of:

creating a finite element model for the aircraft component describing electromagnetic characteristics of the aircraft component;

transforming the finite element model into a plurality of independent modes;

determining, for each independent mode of the plurality of independent modes, a portion of an electromagnetic field contributed by each independent mode;

summing the portion of the electromagnetic field contributed by each independent mode of the plurality of independent modes to calculate a total electromagnetic field for the aircraft component; and

determining the radar cross section for the aircraft component from the total electromagnetic field.

2. The method of claim 1 wherein said step of creating a finite element model for the aircraft component further comprises the step of creating a finite element model of a preselected period of the axi-periodic structure of the aircraft component.

3. The method of claim 2 wherein said step of transforming the finite element model into a plurality of independent modes further comprises the additional steps of:

assembling a system matrix for the finite element model of the preselected period of the axi-periodic structure of the aircraft component; and

applying a Discrete Fourier Transform to the system matrix.

4. The method of claim 1 wherein said step of creating a finite element model for the aircraft component further comprises the step of creating the finite element model using second order edge elements.

5. The method of claim 4 wherein the second order edge elements are curl conforming type elements.

6. The method of claim 1 wherein said step of determining, for each independent mode of the plurality of independent modes, a portion of an electromagnetic field contributed by each independent mode further comprises the additional steps of :

creating a mathematical representation of a reference pipe having an infinite length; and

using the mathematical representation of the reference pipe to determine the portion of the electromagnetic field contributed by each independent mode.

7. The method of claim 6 wherein said step of determining, for each independent mode of the plurality of independent modes, a portion of an electromagnetic field contributed by each independent mode further comprises the additional steps of :

creating a mathematical representation of a test fixture;

creating a mathematical representation of the aircraft component in a cavity;

coupling the mathematical representation of the test fixture to the mathematical representation of the aircraft component to create a mathematical representation of a combination of the test fixture and the aircraft component;

coupling the mathematical representation of the reference pipe to the mathematical representation of the combination of the test fixture and the aircraft component to create a mathematical representation of the reference pipe, the test fixture and the aircraft component having a common interface between the test fixture and the reference pipe; and

solving the mathematical representation of the reference pipe, the test fixture and the aircraft component by introducing a mathematical representation of an incident wave at the common interface of the test fixture and the reference pipe.

8. The method of claim 7 wherein said step of creating a mathematical representation of a test fixture further comprises the additional steps of:

creating a single layer of finite elements describing electromagnetic characteristics of the test fixture;

assembling a system matrix for the single layer of finite elements;

factoring the system matrix for the single layer of finite elements into a test fixture impedance matrix, wherein the test fixture impedance matrix represents end surfaces of the test fixture having a length; and

doubling the length of the test fixture represented by the test fixture impedance matrix until a preselected length of test fixture is represented by the test fixture impedance matrix.

9. The method of claim 8 wherein said step of creating a mathematical representation of a reference pipe having an infinite length further comprises the additional steps of:

copying the test fixture impedance matrix representing the test fixture of the preselected length to create a reference pipe impedance matrix, wherein the reference pipe impedance matrix represents end surfaces of the reference pipe having the preselected length; and

doubling the length of the reference pipe represented by the reference pipe impedance matrix until a length of reference pipe is represented wherein the end surfaces of the reference pipe are uncoupled.

10. The method of claim 7 wherein the mathematical representation of the test fixture, the mathematical representation of the reference pipe and the mathematical representation of the aircraft component are each a super-element and the method further comprises the steps of :

storing the super-elements for the test fixture, reference pipe and aircraft component in memory;

modifying the aircraft component; and

reusing stored super-elements for the test fixture and reference pipe to calculate a radar cross section for the modified aircraft component.

11. The method of claim 7 wherein said step of determining, for each independent mode of the plurality of independent modes, a portion of an electromagnetic field contributed by each independent mode further comprises the additional steps of :

coupling the mathematical representation of the reference pipe to another identical mathematical representation of the reference pipe to create a mathematical representation of a two-sided reference pipe having a common interface;

solving the mathematical representation of the two-sided reference pipe by introducing the incident wave at the common interface of the two reference pipes; and

determining the difference between the solution of the representation of the reference pipe, test fixture and aircraft component and the solution of the representation of the two-sided reference pipe.

12. The method of claim 1 wherein the plurality of independent modes comprises primary modes and conjugate modes related to the primary modes and said step of determining, for each independent mode of the plurality of independent modes, the portion of an electromagnetic field contributed by each independent mode further comprises the additional steps of:

determining an impedance matrix for each primary mode of the plurality independent modes; and

determining an impedance matrix for each conjugate mode by transposing the impedance matrix of the corresponding primary mode for each conjugate mode.

13. A computer program product embodied on a computer readable medium and executable by a computer for calculating the radar cross section (RCS) of an aircraft engine face component, the computer program product comprising computer instructions for executing the steps of:

creating a finite element model for the aircraft engine face component describing electromagnetic characteristics of the aircraft engine face component;

transforming the finite element model into a plurality of independent modes;

determining, for each independent mode of the plurality of independent modes, a portion of an electromagnetic field contributed by each independent mode;

summing the portion of the electromagnetic field contributed by each independent mode of the plurality of independent modes to calculate a total electromagnetic far-field for the aircraft engine face component; and

determining the radar cross section for the aircraft engine face component from the total electromagnetic far-field.

14. The computer program product of claim 13 wherein the step of determining, for each independent mode of the plurality of independent modes, a portion of an electromagnetic field contributed by each independent mode further comprises the additional steps of :

creating a mathematical representation of a test fixture;

creating a mathematical representation of the aircraft engine face component in a cavity;

creating a mathematical representation of a reference pipe having an infinite length;

coupling the mathematical representation of the test fixture to the mathematical representation of the aircraft engine face component to create a mathematical representation of the combination of the test fixture and the aircraft engine face component;

coupling the mathematical representation of the reference pipe to the mathematical representation of the combination of the test fixture and the aircraft engine face component to create a mathematical representation of the reference pipe, the test fixture and the aircraft

component having a common interface between the test fixture and the reference pipe; and

solving the mathematical representation of the reference pipe, the test fixture and the aircraft engine face component by introducing a mathematical representation of an incident wave at the common interface of the test fixture and the reference pipe.

15. The computer program product of claim 14 wherein the step of determining, for each independent mode of the plurality of independent modes, a portion of an electromagnetic field contributed by each independent mode further comprises the additional steps of:

coupling the mathematical representation of the reference pipe to another identical mathematical representation of the reference pipe to create a mathematical representation of a two-sided reference pipe having a common interface;

solving the mathematical representation of the two-sided reference pipe by introducing the incident wave at the common interface of the two reference pipes; and

determining the difference between the solution of the representation of the reference pipe, test fixture and aircraft engine face component and the solution of the representation of the two-sided reference pipe.

16. The computer program product of claim 13 wherein the aircraft engine face component has an axi-periodic structure and said step of creating a finite element model for the aircraft engine face component comprises the additional step of creating a finite element model of a preselected period of the axi-periodic structure of the aircraft engine face component using second order edge elements.

17. A system for calculating the radar cross section (RCS) of an aircraft engine component comprising:

a computer having memory and a processing unit;

means for creating a finite element model for the aircraft engine component describing electromagnetic characteristics of the aircraft engine component;

means for transforming the finite element model into a plurality of independent modes;

means for determining, for each independent mode of the plurality of independent modes, a portion of an electromagnetic near-field contributed by each independent mode; and

means for summing the portion of the electromagnetic near-field contributed by each independent mode of the plurality of independent modes to calculate a total electromagnetic near-field for the aircraft engine component;

means for determining a total electromagnetic far-field for the aircraft engine component from the total electromagnetic near-field for the aircraft engine component; and

means for determining the radar cross section for the aircraft engine component from the total electromagnetic far-field.

18. The system of claim 17 wherein:

the aircraft engine component has an axi-periodic structure;

said means for creating a finite element model for the aircraft engine component further comprises:

means for creating a finite element model of a preselected period of the axi-periodic structure of the aircraft engine component; and

said means for transforming the finite element model into a plurality of independent modes further comprises:

means for assembling a system matrix for the finite element model of the preselected period of the axi-periodic structure of the aircraft engine component; and

means for applying a Discrete Fourier Transform to the system matrix.

19. The system of claim 17 wherein said means for determining, for each independent mode of the plurality of independent modes, a portion of an electromagnetic near-field contributed by each independent mode comprises:

means for creating an impedance matrix for a test fixture;

means for creating an impedance matrix for the aircraft engine component in a cavity;

means for creating an impedance matrix for a reference pipe having an infinite length;

means for coupling the impedance matrix for the test fixture to the impedance matrix for the aircraft engine component to create an impedance matrix for the combination of the test fixture and the aircraft engine component;

means for coupling the impedance matrix for the reference pipe to the impedance matrix for the combination of the test fixture and the aircraft component to create an impedance matrix for the reference

pipe, the test fixture and the aircraft engine component having a common interface between the test fixture and the reference pipe; and

means for solving the impedance matrix for the reference pipe, the test fixture and the aircraft engine component by introducing a mathematical representation of an incident wave at the common interface of the test fixture and the reference pipe.

20. The system of claim 17 wherein said means for determining, for each independent mode of the plurality of independent modes, a portion of a electromagnetic near-field contributed by each independent mode further comprises:

means for coupling the impedance matrix for the reference pipe to another identical impedance matrix for the reference pipe to create an impedance matrix for a two-sided reference pipe having a common interface;

means for solving the impedance matrix for the two-sided reference pipe by introducing the incident wave at the common interface of the two reference pipes; and

means for determining the difference between the solution of the impedance matrix for the reference pipe, test fixture and aircraft engine component and the solution of the impedance matrix for the two-sided reference pipe.